

A Systems Approach to Test the Usefulness of a Model to Challenge Organisational Change

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Abstract

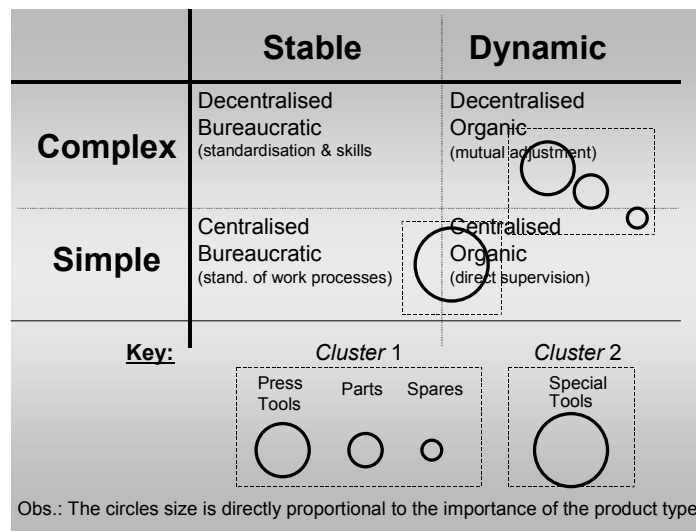
The impact of a proposition concerning the split of the structure of a precision engineering company into two clusters was holistically analysed and verified for consistency, as regards the structure design parameters. A conceptual model supported by both the schools of strategists and structuralists was used as an audit tool for ordered questioning, debate, learning and dialectical discussion. Moreover, the Soft Systems Methodology (SSM), provided orientation to theoretical validation of the model whose outcomes identified the potential, desirable and feasible change of both manufacturing systems and production planning and control (PPC). A situational, hermeneutics, interpretivist, learning oriented process of enquiry, rather different from best practice views, was shown adequate to the problem nature and to the case study confirming the interest of the two clusters. Thus, formal planning and control procedures exhibited a very weak stand requiring both development in line with the contingency factors and complementarity with the other work co-ordination mechanisms. This holistic, systemic, strategic and structured approach produced the reviewing and reformatting of the manufacturing strategy decision areas and recommended that PPC procedures should be further analysed in detail, in order to fit the two clusters. To sum up, the audit tool was found useful and it was also able to identify potential change in a credible way, to classify it as desirable/undesirable by following a learning process and, to discuss its feasibility in the context of a specific organisational culture. Thus, SSM provided an original contribution to Operations Research through the design of complex organisations under a systems view.

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Positioning the presented approach

This paper aims to present a test to the usefulness of a conceptual model as a diagnostic tool for developing understanding about the relevance of the typical planning and control procedures that could be used in an Industrial Case Study Company².

Thus, the paper reports a bottom-up empirical test by discussing the impact of the proposition concerning the split



Source: In Vilas-Boas (2009c).

Figure 1 – Structures matching the SBU clusters

work-coordinating mechanisms across time. The ICSC culture and the relevant organizational power games were also considered in the carried out analysis (Vilas-Boas, 2009c).

Next section will introduce the theoretical background that enabled the grounds for the bottom up empirical test that follows. Finally, last section will present a few relevant conclusions.

Theoretical background

Conceptual model

The model is built up on top of the schools of strategists and structuralists. These help to identify the following variables: i) the structure determinants including strategy as the independent variables; and, ii) the organisational design parameters taking into consideration the strategic decision categories of Manufacturing Strategy, as the dependent variables.

Moreover, the Soft Systems Methodology, provided a significant orientation to the theoretical validation of the model, a necessary and sufficient condition for relevance of the design parameters (DP_i). Thus, it was argued that structure adequateness is achieved if both the conditions of relevance (theoretical validation) and usefulness (empirical test) are achieved for all design parameters (Figure 2).

Thus, the outcomes of the theoretical validation identified the potential change of both manufacturing systems and PPC, enabling a check for both adequacy and completeness (Vilas-Boas, 2009b). This is the developed diagnostic tool. In addition, a

² ICSC – Acronym for designating the Industrial Sponsor

pilot case study was then run to check the model empirically under a *top down* approach, as previously explained (Vilas-Boas, 2009c). This paper addresses the *bottom up* empirical test of the proposition that was found in the top down check. The success of these empirical tests will justify the usefulness of the model outcomes, as an audit tool, in order to challenge, question and discuss the change of the status quo of the 'case' company (*vide* also Silva, 2002: 251 for details).

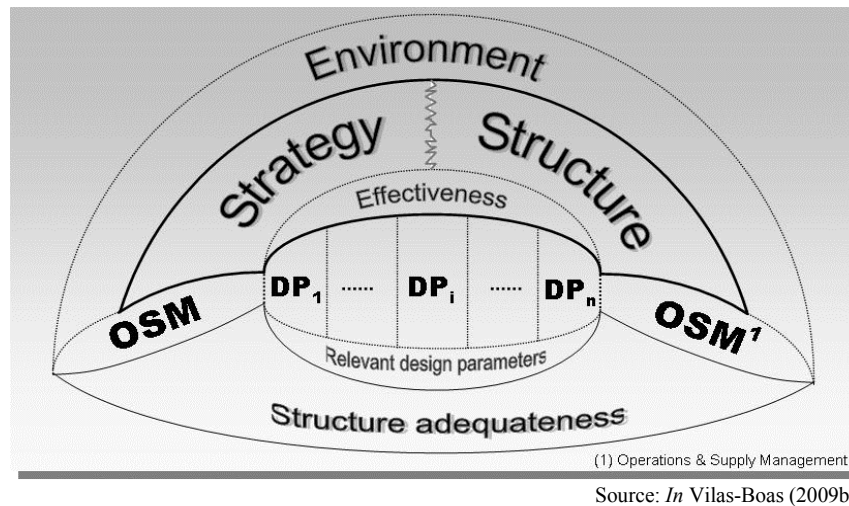


Figure 2 – Proposed framework to define structural adequateness

To sum up, the conceptual model is used as the base for ordered questioning, promoting the debate about organisational change, orienting the learning process from the reality and feeding a dialectical discussion about the situation perceptions (Checkland, 1994: 178).

Design parameters

The cross-check between the design parameters coming from a purely structuralist view and the decision areas from the strategic management background resulted in reviewing the factors relevant to the design of the manufacturing system as *Figure 3* summarises.

The structuralist view is more developed with regard to the design parameters of the organisational structure and also very strong in terms of the relationship between these design parameters and their determinants. However, the strategist perspective completes the structuralist view, including relevant concerns with other functional strategies, *e.g.* Marketing and IS/IT³, as well as it presents more developed, detailed and specific planning and control procedures. Moreover, the strategist view looks more appropriate for manufacturing systems, because it includes specific concerns and an adapted semantic to such issues as capacity, technology, PPC and maintenance.

In addition, both IS¹ and IT¹ perform a supportive role to the manufacturing systems design as it was also identified by Porter (1985) for the technological infrastructure. Therefore, consistency between IS/IT and the design parameters of the manufacturing system should be indirectly assured, through the selection of the right technological options to support the relevant organisational choices.

In summary, the internal consistency among design parameters of the organisational structure and decision areas of manufacturing strategy appears to be well established. Thus, as a result, the decision categories of the manufacturing strategy were reviewed as *Figure 3* exhibits.

³ IS/IT – Popular acronym for designating *Information Systems/Information Technology*

Decision areas	Design parameters
Process choice	<ul style="list-style-type: none"> • Capacity: amount, timing, type, scale economies, role of inventory, break-even-point • Facilities: (i) external requirements (plant size, location, focus, investment); (ii) internal requirements (shifts, overtime, subcontracting, material handling, routings, storage, work environment, workstation layout) • Technology: (i) physical objects (products, tools, equipment, automation level used in their production); (ii) activities or processes (methods of production); (iii) knowledge to develop/apply equipment, tools & methods to produce a particular output • Vertical integration: (i) direction, extent, balance, cost/control; (ii) vendor and customer relationships, inventory role, contracts, SCM, VCM
Organisational structure	<ul style="list-style-type: none"> • Design of positions: job specialisation, behaviour formalisation, training and indoctrination • Design of superstructure: unit grouping, unit size • Design of lateral linkages: liaison devices and general planning and control issues • Design of decision-making: vertical and horizontal centralisation/decentralisation
Planning and control (specific issues)	<ul style="list-style-type: none"> • PPC, i.e., forecasting, demand and inventory policy, ordering, inventories, sourcing policies, capacity allocation, scheduling of activities, decision rules, loading, product flow, schedules, costs, MTO/MTS, manufacturing management, purchasing management, <i>e.g.</i>, value analysis, bids, vendor selection, control system • Quality control, i.e., AQL, error-free policy, scrap, inspection policy, high reliability/low cost trade-off, defect prevention, monitoring, performance measurement and intervention, quality assurance, quality management (cost, design conformance, improvement, SPC), supervision, information systems; TQM policies • Maintenance and reliability of the system, <i>i.e.</i>, maintenance effort, downtime costs, m/c breakdown, scheduling and control of maintenance, technological risk, manufacturing engineering, information systems • Performance measurement, i.e., budgeting and cost control, operational cost balancing, information systems, improvement, definition of standards <i>versus</i> competitive criteria
Labour and staffing (specific issues)	<ul style="list-style-type: none"> • Labour control, i.e., work measurement/standards, industrial engineering, wage payment • HRM policies, e.g., employment security and health, housekeeping, communication, selection, promotion, motivation, appraisal, placement, relations, development and training, remuneration • Management issues, e.g., style, culture, leadership, shared values, integrative functions, etc.

Source: In Silva (2002: 235).

Figure 3 – Design parameters of the manufacturing system

Bottom-up empirical test: results and discussion

This test has challenged the proposition concerning the split of the structure of the ICSC into two clusters by discussing its impact on the design parameters of the precision engineering manufacturing system.

This section will follow the tradition of qualitative case studies going directly from the written-up notes to the case study report. Primary data were gathered through semi-structured interviews and non-structured observation. Secondary data included documentary sources. Moreover, the report will be structured in a narrative text that roughly follows the audit tool guidance (Silva, 2002: 446). The text that follows will address the results and discuss them straightaway.

Process choice

In the ICSC capacity increases in an incremental way, when some market opportunity is spotted, as exemplified by the purchasing of both an overhead crane and a CNC machining centre that will enable the company to expand into the manufacture of larger sizes of press tools (PRT SBU). Despite this strategic reactive stance towards demand there might also be a proactive motivation towards the replacement of old equipment by a more updated one, e.g. the substitution of manual by numeric control machinery. Sometimes, fashion also plays a role in the technology replacement because vendors try to explore the rivalries among the competitors.

In TIM⁴, management is fully concerned with an expansion strategy that pursues the maximization of the capacity utilisation, which might cause a strong opposition to the firm divisionalisation, because of the lower rates of equipment utilisation in 'cluster 2' – special tools (SPT SBU). Thus, both expensive and bottleneck machines are working overtime. In addition, more attention should be dedicated to the computation of accurate hourly machine rates, which are critical issues for company performance. So, the IT resources available on the market should be used in order to better assess and control machine utilisation, working hours taken by the jobs and, materials and overheads allocation, in addition to focusing and simplifying the plants, as regards simplified routings, capacity allocation, plant scheduling and order progress.

The role of inventory is only an issue for the SPT SBU. Both WIP and final product inventory might be adjusted in order to smooth the planning of capacity utilisation. A materials control computer-aided tool could be useful in this scenario. The increasing trend to subcontract might also call for a computer-aided tool.

Mechanisms concerning external linkages should be promoted. For instance, taking action over the company culture is a relevant aspect because TIM should learn how to accommodate a quality audit policy that cross-boundaries (SPT). Moreover, allowing the customers of long-cycle products, such as PRT, to follow the progress of their orders by the internet, in real-time is a further push towards an integrated management package to deal with due date achievement.

As regards facilities, TIM technology is easily divisible according to the SBUs needs. The potential low utilisation of the capacity could be faced as an undesirable cost to be carried out, despite the groupings formed around the market criteria could always look for getting more work to compensate for a higher break-even point. In this way, technology – including both equipment and knowledge – could be more easily classified as either routine or non-routine and, as either long-linked or intensive technologies.

⁴ TIM – Acronym for designating the Industrial Sponsor

While the former may require more standard manufacturing processes, *e.g.*, more jigs and fixtures, non-routine intensive technologies need faster set-ups and flexibility to satisfy the demand for high product variety.

Smaller and more focused facilities are easier to adapt to these different requirements, which would enable a more adequate layout organisation to the SBUs needs, with regard to the PPC design parameters, *i.e.*, stock/flow control, multi/single cycle ordering, push/pull systems and long term/flexible programmes.

The spatial differentiation resulting from the purchase of a company outside the Euro zone would promote the straightest way to stay in control through the planning and control systems supported by the IT ability to telecommunicate.

So far, the ICSC has provided empirical evidence that both contingency factors and process choice issues are mutually significant for the design process of the manufacturing system, in general and, of the PPC procedures, in particular.

Design of positions

Job specialisation

TIM structure is horizontally specialised (H), because jobs are divided into operations that are allocated to specific sections, *e.g.* the milling machine section. However, TIM employs professionals – *e.g.* lathe operators – which means that they hold a significant amount of control over their jobs, *i.e.* the work is not vertically specialised. In summary, work in TIM is much less specialised, both vertically and horizontally (H+V), than in a production line where, tasks have very short operation cycles. Moreover, equipment with numeric control do present a less specialised work (H+V) than manual one.

SPT present a more specialised work (H+V) than the other SBUs, due to the regularity and repetitiveness of the demand and to simpler part design. However, it still is a skilled work carried on a traditional shop floor, characterised by informal delegation of authority, multi-skilled foremen, neither routine nor mechanical decision-making based on human skill and judgement. Therefore, a two-stage phased migration process is advised for 'cluster 2', if divisionalisation is going to be pursued, as follows: rotation of the work firstly and, then skilled co-operative production work.

Behaviour formalisation

In TIM, the behaviour is not very formalised. SPT are adequate to the formalisation by job because it seems possible to attach the job description, since the products are well defined. Since PRT, PAR and SPA are not so well defined, the most adequate is the formalisation by workflow, when changing product. This links the specifications to the job to be done through the work instructions. General rules affecting a large number of people are defined as a complementary behaviour formalisation procedure. Nevertheless, there is failure example, as follows: (i) sometimes route sheets are forgotten and so, they do not follow the work order progress; (ii) some records of defective operations are missing; (iii) after 6 pm there is no control of the material transactions, etc.

Little job specialisation and behaviour formalisation, knowledge share, continuous redefinition of the individual tasks, lateral communication, networked decision-making power, dedicating attention to activities that contribute to add value as perceived by the customer, knowledge and experience preceding loyalty and hierarchy describe TIM structure as organic. This is in line with: (i) the strategic way that the company chose to satisfy the requirements placed by the customer; (ii) the critical success factors

previously identified; (iii) the expected trend in the organisational features that generically match the current strategic business landscape (Vilas-Boas, 2009c).

Three significant lessons were learnt and should be applied, as follows: (i) avoid introducing procedures that may cause either a lack of responsiveness of the structure, such as 'straightjacket' computer packages or that can cause 'bureaupathology' (Tosi, 1984:102); (ii) avoid universal procedures, or best practices that are unable to adapt TIM specific needs; and, (iii) promote the implementation of performance assessment procedures based on teamwork, multi-criteria and focusing on the activities that add value to the customer. So far, the divisionalisation into the previously mentioned two clusters looks a favourable choice that carries on collecting support. In fact, both job specialisation and behaviour formalisation are for it.

Training and indoctrination

The Human Resource Management (HRM) pursued by the operations manager is strictly informal and based on his feelings. One of the detected problems concerned the lack of formal planning of the professional careers as well as promotions without proper training.

Figure 4 introduces a few examples of training topics to compensate for the progress of the formal structure, as follows:

- The Production Manager must be aware/prepared for its responsibilities;

Competencies to be developed	Production Manager	Foremen	Operators	Production Controller	Storekeeper
Leadership and coaching	3	3	-	-	-
Team management	3	3	1	-	-
Teamwork	3	3	3	-	-
Holistic management	3	2	1	2	1
Behavioural management, <i>e.g.</i> , time management	3	3	1	3	3
Human resource management	3	3	-	-	-
Change management	3	3	2	2	1
Fundamentals of manufacturing systems engineering	3	2	-	1	-
Industrial relations	3	3	2	2	2
Specific technical training	-	1	3	-	-
Warehouse management	3	2	1	2	3
Training in other professions	-	3	3	-	-
PPC	3	2	1	3	1
Quality: philosophy, attitude, certification	3	3	1	2	1
Quality control techniques	3	3	2	-	1
Primary maintenance	2	3	3	-	-
Continuous improvement	3	3	2	1	2
Objectives, performance assessment, bonus	3	3	1	2	1
Business strategy	3	1	-	-	-
Operations strategy	3	2	-	1	-
Work study	3	2	-	1	-
Computer literacy	3	3	?	3	1/2
Scale: 1 – light training; 2 – medium training ; 3 – in depth training					

Figure 4 – Some training requirements of production management

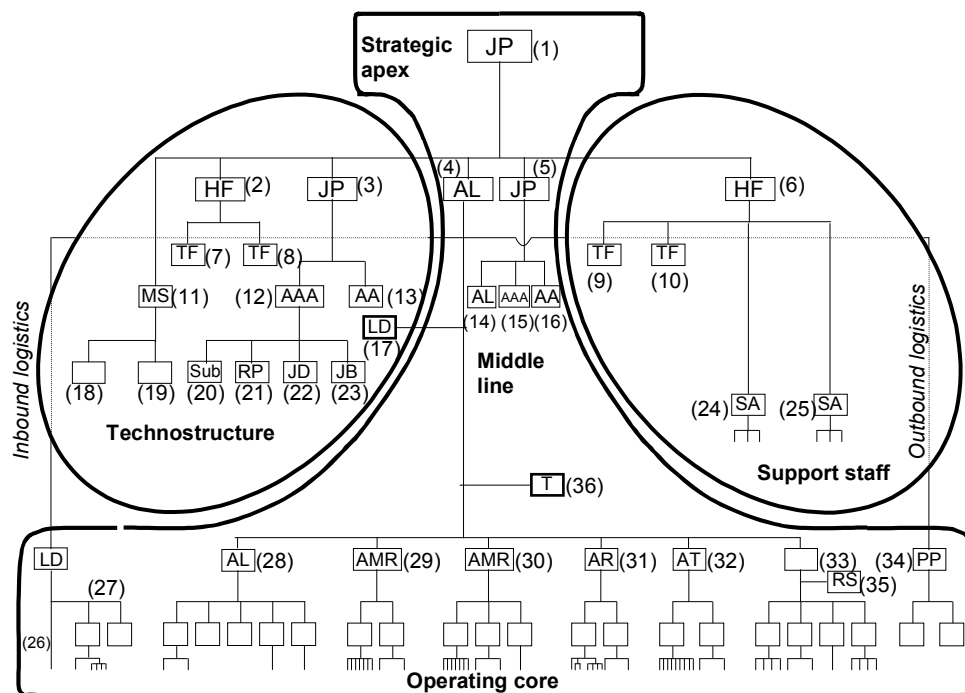
- All foremen (except the CNC) and the production manager should become computer literate;
- Operators and the foremen should develop multi-skilled competencies, *e.g.* maintenance and quality;
- The Production Controller, the foremen and the production manager should be trained in the most important activities for the control of jobbing production;
- Storekeepers should have general training and specific training on materials management;
- The traditional master/apprentice relationship should be recovered.

Finally, activities to strengthen the organisational culture should be implemented. The assessment of these training and indoctrination activities and, of the following-up procedures should be implemented.

Design of superstructure

Unit grouping

The first level of the formal structure of TIM is divided on a functional basis, as *Figure 5* shows.



Source: In Vilas-Boas (2009c).

Figure 5 – Formal flows of authority

The Commercial and Engineering Department uses the workflow interdependencies as criteria for grouping, because its sections are related to the SBUs. The Administrative and Financial Department uses both the scale and the social interdependencies as the criteria for grouping because the amount of work is not enough and the clerical people feel unified by a general social community interest.

The production department is currently structured according to the process interdependency criteria. For the conventional machinery, the grouping bases are the

work processes and the function. However, for the CNCs the grouping basis is the type of control, *i.e.*, the numeric control. In addition, the proposed split between two clusters would generate a typical grouping by market, breaking away from the current situation. This parallel vertical decentralisation would help to focus on the different needs of the clusters and to cope with the increasing variety of the requirements, simplifying the production manager task. In fact, he has recognised that it is very difficult to manage more than 30-40 men following the current mechanisms because of the great complexity of the task.

The current allocation to the SPT, on a full-time basis, of three grinding operators and of two milling operators is a factor that makes the starting motivation easier for the divisionalisation. Perhaps, in a first phase, technologies such as CAD/CAM and DNC might be in a better position, if allocated to a centralised section, supplying services to both clusters. Even so, some increase in costs is expected. If these mechanisms are not enough to assure the required levels of control, then others should be called off, *e.g.* the planning and control systems, resulting in a further increase in the overheads. Thus, to keep profitability, either the sales increase or the margins might be reduced, which supports the considerations about the break-even point made in the previous top-down analysis of the contingency factors (Vilas-Boas, 2009c).

TIM's life cycle has been strongly influenced by changes in its superstructure – *i.e.* unit grouping and size – both in its facilities and technology.

Unit size

At the Strategic Apex the Managing Director (MD) supervises the four heads of department. The MD is also the Head of the Commercial and Engineering Department which helps to promote his strategic view of the business. It is believed that the MD should be more available to think the organisational structure. His participations in the work constellations are an important activity because it promotes the convergence towards the business interest, rather than the functional one.

The engineering competencies of the MD should aim at vertical selective decentralisation to the Head of the Commercial and Engineering Department which should be a nominated director, if TIM starts to expand to a holding of independent SBUs. Considering the current span of control, the MD responsibilities look reasonably balanced with his authority. The nomination of an assistant is an alternative. He/she should dedicate to the leadership of continuous improvement projects, as well as to perform a significant role promoting the liaison between departments, *e.g.* quality and production.

In the Production Middle Line, the Production Manager directly supervises five section foremen, the inbound and outbound logistics and also, the subcontracting activities and services, *e.g.* the heat treatment. He is helped by the production controller as staff.

The introduction of the section foremen still presents much room for improvement, because many of the functions of the previous general foreman were not completely/correctly delegated. Both the development of two clusters and the strengthening of the control procedures are possible moves. Other potential improvement would be the creation of a position for an assistant to the production manager. His/her function should concern the following aspects: (i) development of the liaison with the production controller; (ii) development of the of the liaison with the quality department; (iii) supervise the subcontracting activity; (iv) continuous improvement of the manufacturing system; (v) training of the human resources; (vi) strengthen the line liaison to the CNC section; and, (vii) assure the administrative

procedures on the shop floor. The production manager assistant could generate some undesirable difficulties in the relationship with the current production manager, if the process of introduction was not clear and properly managed. However, great care should be taken, with regard to the company culture and also, to the power games in place.

Design of the lateral linkages

Planning and control systems

In TIM, there is no formal operating plan, *i.e.*, neither budgets nor sales targets are specified. The lack of action planning seems to affect both business and shop floor levels.

The following are examples of functionalities of the current CAPM system that do not work: (i) materials not properly coded; (ii) incomplete, few operating sequences; (iii) inexistent bills-of-materials; (iv) stock control of both raw and maintenance materials not working; (v) current CAPM package (GPM) is not used to compute costs and prices; (vi) work centre data are inaccurate; (vii) GPM is neither used to collect automatically data, nor to database; (viii) GPM is neither used to support machine scheduling nor to simulate loading; and, (ix) GPM does not support budgeting. The following are examples of a few functions of GPM that are working: (i) definition, printing and closing of work orders; (ii) consultation of the work orders relating to the work-in-progress; (iii) keeping the workstations file; and, (v) keeping the customers file. Therefore, TIM is a 'Class D' user, according to Oliver Wight. This means that 'information provided is inaccurate and poorly understood by users, providing little help in running the business' (Sousa, 1993: 71).

With regard to quality control and assurance the situation is, as follows: (i) the metrology section works well; (ii) there is a quality manual; and, (iii) there is no established attitude towards continuous improvement. The quality assurance manual represented an enormous effort, despite some criticism, as follows: (i) developed under both a reductionist and a functional approach; (ii) needs to be reviewed within the business scope; (iii) needs to be implemented not only within the scope of the quality function; (iv) needs to be understood as needed by business as a whole and its ownership should be returned to the business. In addition, conformance with the specification, reliability, durability and quality perception are quality dimensions related to error-free processing and to elimination of process variability that still needed to be achieved. Thus, TIM is a 'Class C' user. This means that 'processes are being utilised in limited areas and that some departmental improvements have been achieved' (Sousa, 1993: 31).

Corrective maintenance is the current practice. Most of the production operators do have considerable experience with their machines which they use to recall for help on troubleshooting. Despite equipment operating reasonably, keeping records about equipment failure and history is not formally pursued because it does not 'pay off'. However, the company is thinking of reviewing its practices, due to the increasing technological sophistication. TIM is a 'Class D' user because formal processes are not established.

The typical approaches to cost accounting and performance control have also been reductionist and functionally focused. The support provided to the production manager task is reduced. Cost accounting system ignores the possibility of automatic data collection or of interfacing with a potential PPC package. The 'system' is a low profile 'Class C', meaning limited improvement, poor information and little help to run the business.

A performance control system should be SBU specific, as follows: (i) for SPT, PPC should be able to replace the current stock control system; (ii) for PRT, the system should be able to compute complex bills-of-materials, to simulate several scenarios for the start and finish dates of component manufacturing and, to set up different purchasing schedules; (iii) for PAR, indices about demand repetitivity should be required; and, (iv) for SPA, the administrative overheads should be balanced and evaluated against the other incurred costs. Finally, performance measures should be multi-dimension and they should provide a relevant support to shop floor management avoiding misguiding the decision-makers. The chosen CAPM should be able to satisfy the reporting needs of TIM through either customisation or parameter choice.

In summary, all the reporting and control procedures should be defined based on the business interest. Moreover, the data collection supporting system structure should focus on the control needs of the business processes and SBUs. Thus, a study of the information requirements for the business must be carried out to satisfy the need of investment in formal control procedures.

Liaison devices

Liaison devices complement planning and control procedures and they are, as follows: the technical committee and, the role performed by one of the founders and previous managing director, until the late 1990s. The assistant roles described in the unit size may be considered as performing a liaison role.

It seems adequate to create a permanent committee dedicated to continuous improvement and innovation, as follows: (i) permanent members – all the heads of department and the managing director; (ii) invited participants – other collaborators and external consultants. The committee should meet regularly, about once per month, it should help the busy front line managers to accomplish not regular functions that contribute to reinforce the solution of the problems, in the scope of the business, without exclusions.

Design of the decision-making system

Vertical and horizontal decentralisation

Structuring the organisation, namely, the motivation towards a continuous improvement attitude, the spread of the quality philosophy, the formalisation of the control procedures should be centralised in the Managing Director (MD). As soon as these functions start to stand by themselves they should be returned to the technostructure and to the line managers.

Moreover, the MD should make himself available by vertical decentralisation of some engineering competencies to the CNC foreman and to the engineering department; and, of some commercial competencies to the commercial department. Perhaps, a head of the Engineering and Commercial Department should be recruited and, the participation of the MD should be reduced to the work constellations.

If TIM is divided into two clusters, the production manager (AL) should delegate power to the sales engineer in charge of the special tools through parallel vertical decentralisation and so, AL will only keep a light supervision of SPT. Thus, AL will get more time to dedicate to press tools, parts and spares. AL might also be tempted to promote the parallel vertical centralisation from the section foremen to compensate this loss. Instead, AL should rather spend more time improving the co-ordination of the foremen and, reinforcing selective vertical decentralisation. AL should also build up a closer relationship with the production controller (LD) in order to improve the

effectiveness of the PPC procedures and so, satisfying the greater business requirements for formal control (Vilas-Boas, 2009c). This might require a selective horizontal decentralisation from AL to LD, because AL has traditionally kept a tight hand on the production control procedures. In addition, LD should acquire more competencies and better tools to help him to perform a better role. In fact, more effective PPC could also cause a selective vertical decentralisation, which might not please AL, since he is used to having full control of the shop floor.

If the two clusters split, the degree to which the clusters should be spatially differentiated should enable sufficient distance for avoiding some temptation of 'too much' parenthood from the 'cluster 1', *i.e.*, from AL towards 'cluster 2', *i.e.*, to the sales engineer in charge of the SPT (AA). The procedures should also become very different and, the autonomy of 'cluster 2' would increase the potential of shop floor transfer to further places. This is a possibility because cable industry is moving away and proximity is a key requirement to supply it. In this case, the split strategy would positively affect future moves because it promoted autonomy, more SPT robustness and the development of younger leadership (AA). Recent investments in Brasil may also benefit from these aspects if there is a need to transfer staff.

In summary, the role of the production manager would become weaker, if the two clusters split and if functional control procedures were implemented. The coaching component should increase while the direct decision-making decreases. TIM should prepare its human resources for this new reality despite all care should be taken because these moves could represent a serious threat to the unit of command. Furthermore, the organic characteristics of the structure are under different pressures, as follows: while technology is empowering the operating core, formal control procedures increase both the behaviour formalisation and the potential of telecommunication and so, reduce the empowerment effect. In addition, the possible split into two spatially differentiated clusters would increase their autonomy through direct parallel vertical decentralisation. As a consequence, it is difficult to have a quantitative opinion about the final balance with regard to the impact in the defining characteristics of the structure. However, potential changes should impact both structure and operations, in the same way that they are expected to affect the critical success factors, to support competitive advantage.

Conclusions

In this paper, the impact of a proposition concerning organisation divisionalisation was holistically analysed and verified for consistency within a precision engineering company.

The industrial case study (ICSC) fully accomplished the targets of enabling the perception of the reality and of developing understanding of the situation under investigation. Moreover, the 'issues leading the enquiring questions' resulting from the previous theoretical validation of the conceptual model (Vilas-Boas, 2009b) were successfully applied as both an audit and a diagnostic tool to identify some desirable and feasible change concerning not only the PPC procedures, in general, but also the manufacturing systems structure. Indeed, the ICSC provided a relevant contribution to the empirical validation process, as a source of debate and learning. Thus, the developed conceptual model is considered empirically validated for this purpose, in the case of a small precision engineering company.

In fact, the 'issues leading the enquiring questions' oriented the learning process in two stages, as follows: (i) firstly, a top-down analysis determining the desirable change from the contingency factors, *i.e.* the split of the organisation structure into two clusters (Vilas-Boas, 2009c); (ii) secondly, a bottom-up check confirmed the desirability and

checked the feasibility of the identified change, as it was just showed in this paper. As further work, it is recommended that each of the PPC procedures should be analysed in detail, as regards its specific relevance. This represents the final check of both desirability and feasibility of the manufacturing systems change focusing on PPC, as *Stages 5 and 6* of SSM establish. This research should also be replicated for other design parameters and in other case contexts.

As regards the methodology, a situational, hermeneutics, interpretivist, learning oriented process of enquiry was shown adequate to the problem nature and to the case study, confirming the previous proposal (Vilas-Boas, 2009a). Otherwise, it would have not been possible to customise and adapt the relevant practices and techniques concerning the situation. Moreover, considering the business as the unit of analysis proved to be a good choice to address the case study. At last, the problem approach showed up as different from current consultant action, which is closer to pure best practice. So, this holistic, systemic, strategic and structured approach is expected to contribute to a positive differentiation that might support the creation of competitive advantage. After all, this is the desired role that strategy should play.

Regarding the practitioner, the reviewing of both the manufacturing systems structure and PPC procedures were found as relevant contributions of the investigation and they are expected to be significant contributors to both operations performance and PPC success in TIM. For instance, the bottom-up diagnosis found a very weak stand of the formal planning and control procedures in TIM, according to the 'ABCD Oliver Wight checklist'. The analysis also determined the need for their development, in line with the demands placed by the structure determinants confirming the requirement of alignment between PPC and the contingency factors with regard to operation and implementation, confirming previous findings (Vilas-Boas, 2009c). Moreover, the need for complementarity with the other work co-ordination mechanisms was also found significant.

At last, it is argued for a contribution to theory, as regards the reviewing and reformatting of the decision areas of the manufacturing strategy denominated as design parameters of the manufacturing system (*Figure 4*). Some of these design parameters were not explicitly addressed, namely other planning and control than PPC and, labour and staffing. In fact, it was not found relevant to detail labour and staffing, while the other control 'systems' just play a boundary role, being called in, only if and when necessary. In addition, identifying relevant PPC procedures, was a step further, to test the mid range theory proposed by the author (Vilas-Boas, 2009b), in order to find adequate organisational structures to strategic business development.

The final conclusion is that the previously developed audit tool was able (i) to identify potential change in a credible way, independently and, focusing on the business interest, (ii) to classify it as desirable/undesirable by following a learning process and, also (iii) to discuss its feasibility in the context of a specific organisational culture. Thus, it is argued that both the SSM choice and its operationalisation in a useful method were original, relevant, updated and unusual contributions to the design of enquiries concerning complex organisational situations. Moreover, advances in organization behaviour were also integrated into Operations Management Research under an original systems view.

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